

NASA Chat: Landing on Other Planets – How Hard Can It Be?
Experts Dr. Greg Chavers and Dr. Barbara Cohen
October 13, 2011

Moderator Brooke: Hi everyone, thanks for joining us! Barbara and Greg are ready for your questions, so let's get started...

TonyD88: Hello! So I guess I'll be the first to set off the questions. haha

Greg: Please, do!

Super: are there any videos done on simulation?

Greg: Which simulation? If you mean simulating the touchdown, we have simulation of that.

Moderator Brooke: By the way, here's the link for that animation: Robotic Lander Site,
[*http://www.nasa.gov/mission_pages/lunarquest/main/index.html*](http://www.nasa.gov/mission_pages/lunarquest/main/index.html)

TonyD88: So i was wondering how long does it take when you send a spacecraft out to space to communicate with it. For example the roovers on mars are controlled here. but how long does it take for that signal to hit the rover to lets say turn right before it falls down a cliff

Greg: To the Moon, it's 1.2 seconds to get a signal. The further distance it is, the longer it takes. Several minutes to Mars. Several hours to Pluto.

Angora: what other planets does nasa plan on exploring besides mars

Greg: All of them; it's just a matter of priority. Mars is the top priority. Besides the planets, we're also exploring the moons of planets and asteroids. We're discussing a landing on Europa, a moon of Jupiter.

Super: this certainly is is great topic, is landing more had on earth or on moon... or on mass

Greg: It's different. Mars and the Earth have atmospheres so aerodynamic landings are possible. Since the Moon has no atmosphere, retrorockets are required to land on the Moon.

Astronerd: Which location, in your opinions, is the most important place for us to go to next? And why?

Greg: In my opinion, we should soft land on the Moon next, like an Apollo landing. This is for two reasons. One to verify engineering capability since it's been forty years since we last landed. And scientifically, we can put better instruments on the Moon to research and understand the Moon.

Moderator Brooke: Thanks for the quality questions that you're sending in -- Greg and Barbara are working on their responses. Do YOU have a question about landing on other planets? Don't be shy -- this is your chance. (Thanks for staying on-topic -- it's appreciated!)

LisaandAmelia: What type of fuel do you usually use?

Greg: For lunar missions, the best retrorockets for large changes in velocity are solid rocket motors similar to the boosters on the Shuttle, except smaller. For small changes in velocity, liquid propellant

NASA Chat: Landing on Other Planets – How Hard Can It Be?

Experts Dr. Greg Chavers and Dr. Barbara Cohen

October 13, 2011

thrusters which generally have better specific impulse, or gas mileage, are used because they can be started or stopped, whereas solid rocket motors can't be stopped once started.

Micky: How do you simulate a touch down ...what are the major parameters considered for simulation?

Greg: Parameters considered for the simulation are lateral and vertical velocity. For a soft touchdown, vertical velocity less than 3 meters per second are desired to prevent overstress of structural componets. Lateral velocities are desired to be low to prevent the lander from tipping over as it touches down.

Kanushka: Are these robotic landers given a set of instructions to activate at certain times or is it directly controlled on Earth? If so wouldn't there be a delay of receiving the transmission?

Greg: Yes, they are given commands to activate at a certain time and these commands are informed by onboard sensors. Our lunar lander is completely autonomous during landing because of the delay in sending the transmission from Earth and the lander receiving it as it lands.

Sava_ITA: When you decide to go on another planet, what is the first problem ?

Greg: The first problem is budget and then getting off this planet.

TonyD88: What is your essential goal in sending these spacecrafts out there. Are you potentially exploring possibilities of creating a space station on another planet and/or moon

Greg: One of NASA's primary goals is to extend life to other destinations in our solar system.

Moderator Brooke: Thanks for your patience as Greg and Barbara answer your great questions!

MrScorpio: Greetings All the way from London England! - Firstly thank you for sparing your time to host this chat. A question for Greg. More concerning Robotic Landers once on the surface. Given the unprecedented success of the Mars Rovers, the fate of Spirit, must have surely highlighted vulnerabilities? What lessons might be learned regarding how 'resilient' a future rover will have to be, in order to withstand more 'rugged' terrain? - Are wheels always the best answer?

Greg: For the Moon, some missions allow the use of wheels on the rover. However, there are other solutions that are being investigated, such as using the lander to hop several miles to another landing site.

VKiNG: Hi, my question (regarding curiosity mission) is: what are the possible (biggest) dangers during the landing stage and are you prepared for all of them? Thanks!

Greg: During landing on the Moon, the landing phase takes place in less than two minutes, so therefore the lander must be completely autonomous --- no communication from Earth. Because of craters and

NASA Chat: Landing on Other Planets – How Hard Can It Be?

Experts Dr. Greg Chavers and Dr. Barbara Cohen

October 13, 2011

boulders in the touchdown area, the lander should have the ability to see and avoid these hazards. That's the biggest difficulty on landing.

jeff44663: From an orbital dynamics perspective, for an interplanetary probe, wouldn't it make more sense, and be more fuel-efficient, to have the spacecraft first enter an orbit around the planet, say Mars, then descend to the surface from there, rather than making a direct entry at interplanetary speeds? This would be similar to what was done with the lunar landings.

Greg: If you need to leave something in orbit to come back to, then it makes sense. Otherwise, it's more efficient to do a direct landing, because you use energy to establish the orbit and more energy to de-orbit for landing. That total energy is more than if you do a direct landing.

gary7: Hi, great site! Lots of luck for the mission and my question is what is the resolution of photos of the proposed landing site and the odds of the lander encountering a large boulders or any type of object that would put the mission in jeopardy? Does it have any avoidance systems built in?

Greg: We're currently developing the hazard avoidance systems for landing in areas with lots of boulders and craters.

VKiNG: The technological advancement nowadays is incredible, how outdated is the technology on the robotic lander and would it be much better if you could put the tech from today on it?

Greg: Yes, we ARE updating the technology based on current state of the art.

Aldemar: do you use radar(doppler effect) for terrain mapping just before landing?

Greg: For our robotic lander, we do not use terrain mapping for landing. However, for landing on the Moon, terrain maps are used based on previous missions, Lunar Reconnaissance Orbiter (LRO) and Lunar Mapping and Modeling Project. For more information, go to <http://www.lmmp.nasa.gov>.

moonlanding1969: Are we thinking about landing on mars?

Greg: Yes.

moonlanding1969: Is there any possibility of us ever living on Mars?

Greg: Yes.

Sava_ITA: i never understand what the specific impulse is. Could you explain quickly ?

Greg: It's similar to gas mileage.

Kanushka: How large was the team that worked on the Curiosity rover's project?

Greg: I'd check with the Jet Propulsion Lab, since they developed the rover. <http://www.jpl.nasa.gov>

NASA Chat: Landing on Other Planets – How Hard Can It Be?

Experts Dr. Greg Chavers and Dr. Barbara Cohen

October 13, 2011

Aldemar: How many and what kind of sensors do you use for landing?

Greg: For landing, one sensor is an altimeter to determine height above the ground. Another sensor is an inertial measurement unit that determines velocity and acceleration of the lander. These are the minimum. Other sensors may include cameras for hazard avoidance.

Joequinn: Will exploration always be done by one main lander, or would you consider having many smaller robots diving up the task?

Greg: Yes. There are mission studies that look at having an armada of spacecraft.

Moderator Brooke: Wow, great questions coming in. Keep them coming as Barbara and Greg work on their replies.

Wannabe: how does the aircraft know where is the best surface for touchdown?

Greg: Depending on the specific mission, an area without many rocks or boulders can be picked and statistically we can estimate that a touchdown will occur without coming in contact with a boulder or crater. Or onboard sensors can be used for more complex landings if we are landing in areas where there are lots of hazards, such as boulders or craters. Our current lander has a very accurate navigation system for precision landing so we can pick a small spot without boulders for landing.

Guest: did anyone think on installing a high resolution webcam on a moon lander. if it is controllable via internet for anyone, it would be most popular in education and public. to not interfere with science experiments it could be switched on after the primary mission is if fulfilled.

Barbara: Yes, we've thought about that. It would be a good addition.

LisaandAmelia: Do the landers ever come back to Earth or are they permanently left wherever once the mission is over? And if left there, how many are currently out there from previous missions?

Barbara: There are lots out there. Depends on what the mission is...there have been several sample return missions where capsules come back to Earth with samples inside, such as Stardust and Genesis.

Kanushka: How much years is dedicated totally into creating a mission? Could you also explain how difficult it is to land on a planet, with a simple example?

Greg: At least three for the simplest planetary mission we have. More complex missions require decades. Most people think landing is a simple task. You have to have a pretty proven landing system when you're coming into a planet with no atmosphere at a high velocity of (over 5K miles per hour) and then you have to slow to almost zero velocity just before touchdown using retrorockets. That takes skill and precision timing. Otherwise you could lose you'll hit the surface too hard and destroy your lander or run out of fuel at too high an altitude.

NASA Chat: Landing on Other Planets – How Hard Can It Be?

Experts Dr. Greg Chavers and Dr. Barbara Cohen

October 13, 2011

Kwit: I don't know if this still belongs to your department, but Robert Zubrin described in his book Case for Mars the In-situ resource utilization. Is it still an opportunity for a manned mission to Mars?

Barbara: One of the experiments or payloads that our lander could fly would be an ISRU package. We've looked at some of those --we'd certainly be interested in flying one of them.

VKiNG: Landing (in itself) where, would be most interesting in your opinion?

Greg: I'm an engineer and physicist by trade. I want to develop the capability to go anywhere. That's where I get my satisfaction.

gary7: PARACHUTES? RETROROCKETS? WHY have the landers go all the way down when they could deploy a expendable self controlled mini drone at high altitude to study the atmospheres and terrain of the planet rather than be stuck in one concentrated area. Sounds far-fetched 2 U????

Greg: To land on an airless body like the Moon, you can't use parachutes. This is an interesting approach for a planet with an atmosphere.

Kwit: It's hard to find data about VASIMR. I hope you can tell how the actual development is going on and if it will be an opportunity to get to Mars in a shorter time.

Greg: I did my PHD on this subject. I can look up a website that we'll post when we publish the chat transcript.

Curiosity: Hello everyone, can rovers that NASA sends to Mars take some decisions without instructions?

Greg: Yes, they can.

Joequinn: What measurements will the lander make once on the lunar surface?

Barbara: The lander we're developing could carry all sorts of instruments and payloads. Some of the things we've looked at carrying include a mass spectrometer that can look at different molecules; remote sensing instruments that can look at minerals; and geotechnical experiments that investigate lunar soil and other experiments like seismometers to look deep inside the moon.

CZoop; hello, my question is: Do these robotic landers have an AI and how advanced does it have to be to carry out tasks on the planet?

Greg: The robotic lander we're developing does not have artificial intelligence. It is a computer that contains preprogrammed scripts that are informed by onboard sensors.

codeTom: Can you control retrorockets after ignition?

NASA Chat: Landing on Other Planets – How Hard Can It Be?
Experts Dr. Greg Chavers and Dr. Barbara Cohen
October 13, 2011

Greg: The solid rocket motor retrorockets can only be steered after ignition and cannot be shut off. The liquid propellant rockets can be shut off.

gary7: Hey great chat on this site, does your team have a twitter or facebook page?

Greg: Yes, we have a Facebook and Twitter account. I'll have the links put in the chat transcript.

capt_harlock: the problem for the moon or any other object is latency speed of light . Moon is about 1 to 2 light seconds away anything else can be minutes to hours away so we are seeing them in thier "past" reltivy speraking so 2 way communication is a problem

Greg: Two way communication is a problem when fast response is required.

Greg: Thanks everybody for participating and the great questions. I really enjoyed the chat and hope you learned about some of the great work NASA is doing with robotic landers. Our robotic lander prototype is currently being tested in flight in Huntsville, Ala.